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SOLAR PHYSICS OBSERVATORY

NINTH ANNUAL REPORT OF THE DIRECTOR OF THE SOLAR PHYSICS OBSERVATORY TO THE SOLAR PHYSICS COMMITTEE

1921 APRIL 1—**1922** MARCH 31

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1921 APRIL 1—**1922** MARCH 31

Ninth Annual Report of the Director of the Solar Physics Observatory

27 *May* 1922.

The Vice-Chancellor begs leave to present to the Senate the following Report which the Solar Physics Committee have received from the Director of the Solar Physics Observatory:

The Report here presented relates to the year 1921 April 1 to 1922 March 31.

There are no changes to record in the Staff of the Observatory.

Mr Stratton continues research work on stellar spectra.

Mr R. Sekiguchi, lately Assistant Director of the Imperial Marine Observatory of Japan, at Kobe, has come to the Observatory to gain experience in solar researches.

Mr E. S. Pearson completed his study of the structure in the bright lines of Nova Aquilæ, and went out of residence at Cambridge in the summer of 1921.

It is with great regret that the death of Mr W. E. Rolston is recorded. His resignation of his post on the Staff was mentioned in last year's Report. He had remained with the Army of Occupation at Cologne as Managing Director of the *Cologne Post*, and died after a few hours' illness on 9 August 1921.

A. *Stellar Work.*

The first draft of the manuscript giving the results of the measurements and discussion of the series of spectra of Nova Aquilæ III which were lent to the Observatory by the Director of the Victoria Observatory, B.C., has been completed by Mr Baxandall.

The measurements made by Mr E. S. Pearson on the structural details in the broad emission lines in the spectra of the same Nova have been reduced and discussed by Mr Pearson. These two comprehensive pieces of work will now be prepared for press, and it is expected that they will form Parts 2 and 3 of Volume IV of the Annals of the Observatory.

The spectrograms of Nova Cygni III 1920 obtained at Cambridge in September 1920 have been measured and discussed by Mr Stratton. The results of his work have been communicated to the Royal Astronomical Society (*Monthly Notices*, **82**, 44).

The spectrum of the well-known variable star β Lyræ has been further studied by Mr Baxandall and Mr Stratton. For this purpose 64 spectrograms were obtained by Mr Manning with a two-prism spectrograph attached to the Newall Telescope during the summer months of 1921. Thirty of the best of these have been measured in detail by Mr Baxandall. The indications of the results are that the system of β Lyræ contains probably at least four components in relative motion. Dr H. D. Curtis, of the Allegheny Observatory has been so kind as to lend the negative spectrograms of a series of 96 spectra of the star taken in 1907 by Dr R. H. Curtiss. The Cambridge photographs have a linear dispersion nearly twice as great as that of the Allegheny photographs: and it is hoped that the two series may together throw light upon the interpretation of the phenomena presented by this interesting star.

For an experimental study of the distribution of energy in stellar spectra by means of an adaptation of Merton's method of using a coarse diffraction grating crossed with a prism in a stellar spectrograph, the Director and Mr Milne have devoted a considerable time to the practical ruling of coarse gratings ruled in black ink on a gelatine film on glass. Some of the preliminary gratings ruled in the summer of 1921 were used for trials on bright stars, and the best ratio of transparent space to the grating interval for a given exposure time for stars of a given brightness was found. Optically worked glass is now being obtained for the required definitive gratings.

Further theoretical problems related to stellar atmospheres have engaged Mr Milne's attention. A paper entitled "Radiative Equilibrium: the effect of a strong absorption line" was communicated to the Royal Astronomical Society (*Monthly Notices*, **81**, 510). An investigation of the relation of the distribution of energy in the continuous spectrum of a star to the theoretical darkening of the star disc towards the limb with special reference to the effects of selective absorption and scattering has been undertaken and applied in detail to the sun. This paper is nearly ready for publication. The problem is of importance in its bearing not only on the deduction of the orbits and density of eclipsing binary stars but also on the deduction of the angular diameters of stars from interferometer measurements.

A list has been prepared by Mr Moss, which gives for stars visible to the naked eye a quick reference to the serial number and spectral classification in the new Henry Draper Catalogue.

B. *Solar Work.*

Spectroheliograph. Photographs of the sun's disc in Calcium $K_{2.3.2}$ light have been obtained on 115 days (previous year 74), and photographs at the limb on 104 days (previous year 53). The photographs are taken on alternate days by Mr Butler and Mr Moss.

The general activity of the sun as evidenced by the calcium flocculi has gradually decreased during most of the year; but a remarkable revival of spots and flocculi occurred during February and March 1922.

The 18-inch and 6-inch mirrors were dismounted on 9 March 1922 and were remounted on 14 March after being resilvered.

The Director of the Kodaikanal Observatory has sent 335 spectroheliograms showing the sun's disc in Calcium $K_{2.3.2}$ light for the year 1921 January 1—December 31. Of the 30 days missed in the Kodaikanal record, there are Cambridge records for 11 days.

Photoheliograms. Daily photographs taken with the Dallmeyer photoheliograph at Dehra Dûn have been received as usual and the negatives are stored at the Science Museum at South Kensington.

Study of the Spectroheliograms. The valuable series of spectroheliograms, which have been sent for many years past from Kodaikanal, have been examined in detail by Mr Butler in search of evidences of system in the forms and distribution of the clustered masses of bright calcium flocculi. These masses, of which more than 2300 have been passed in review, have been found in a great many cases to assume forms elongated rather than circular or irregular. The percentage of elongated masses varies with the epoch in the sunspot cycle. The inclinations of the longer axes of such masses to the parallels of solar latitude have been systematically measured and studied on all the records available for the six years 1915—1920. The inclinations are found to be generally directed equatorwards to the west in both hemispheres. The range of inclinations of the flocculi is considerably greater than that found for elongated spot groups. The records studied relate to years which embrace times of small and of great solar activity, with the maximum in 1917; and the systematic trend of the inclined axes is sustained in both hemispheres throughout all the years dealt with.

Study of Records of Sunspots and of Prominences. The examination of the proper motions of groups of sunspots referred to in last year's Report has been continued by the Director and Mrs Beech and by Mr Moss. It was however found desirable to make a digression into the study of the movement of zones of prominence activity. Mr Moss in particular has by a judicious choice of a method of graphical treatment of the daily records found indications that at certain epochs in the sunspot cycle there are three distinct zones in solar latitude of prominence activity in each hemisphere. The identification of these zones is evidence of a pronounced localization of the distribution in longitude.

Spectroscopic Determination of the Solar Rotation. Spectroscopic observations, made for many years past, have shown that the absorbing vapours round the sun are rotating with angular velocities which depend upon the latitude, and are greatest at the Solar equator and diminish with some semblance of regularity with increasing latitude. The implications of the law which is generally accepted for this variation of angular velocity in latitude have been examined by the Director in a paper communicated to the Royal Astronomical Society (*Monthly Notices*, **81**, 101); and in a further short note (*Monthly Notices*, **81**, 115) he has indicated a new method of securing observations for the determination of the Solar rotation in either hemisphere of the sun. The method has several advantages over previous procedure. The auxiliary apparatus for using the method at Cambridge has been added to the McClean Solar instruments, and is now in use. Mr Sekiguchi is assisting in the work involved in the trial of the new method.

The three lines of investigation indicated in the three last paragraphs are all directed to gaining more definite knowledge of the processes of the circulation of the Solar vapours.

C. *Meteorological Physics.*

Atmospheric Electricity. Mr C. T. R. Wilson has continued his observations and experiments relating to the electrical phenomena of thunderstorms and showers. In spite of the small number of thunderstorms during 1921 many records were obtained of the changes produced in the electrical field by lightning flashes. Information gained from these investigations has been utilised in an article on Atmospheric Electricity contributed by Mr Wilson to Sir Richard Glazebrook's *Dictionary of Applied Physics.*

Work on Ionising Radiations. Many improvements were made during the year in the details of the method of photographing the tracks of ionising particles. The improved apparatus has been in continued use since November and several hundred stereoscopic pictures have been obtained of the tracks of α and β particles. The action of X-rays has been specially studied, the initial direction, form, range and distribution of the β-ray due to X-rays being very clearly shown in the photographs.

A number of new features have been observed. One of the more remarkable among them is the following: viz. that near the point of origin of a β-ray emitted in air exposed to X-rays, there is frequently found another track of extremely short range. This feature receives an interesting interpretation in terms of the quantum theory. The two tracks are almost certainly due to two β-rays of which the first is associated with the emission, the second with the absorption, of one and the same individual quantum of characteristic or fluorescent X-radiation.

D. *Miscellaneous.*

Lectures. Lectures have been given by the Director in the Michaelmas Term 1921 on the Rotation of the Sun; by Mr C. T. R. Wilson in the Michaelmas and Lent Terms on Atmospheric Electricity; by Mr Stratton in the Lent Term on Stellar Physics; and by Mr E. A. Milne in the Michaelmas and Lent Terms on Radiation Theory.

Staging in the Reflector Dome. The staging which was designed in 1914 by the Director for giving access to the eye end of the 3-foot reflecting telescope has been completed by Messrs Cooke and Sons from the working drawings prepared by them. It is now possible to proceed with the completion of the mounting of the telescope.

Library. A number of valuable publications, reports and reprints have been received in the course of the year, and the Director desires to record his grateful acknowledgments to the donors. A list of the more important donations is appended.

H. F. NEWALL.

Solar Physics Observatory,
10 *May* 1922.

The Director gratefully acknowledges the receipt of the following works, which have been presented to the Library of the Solar Physics Observatory:

ASTRONOMY.

	Donors.
Antwerp, Société d'Astronomie. Gazette Astronomique. Nos. 90—97. Anvers, 1921–2. 4to.	The Society.
Barcelona. Boletin del Observatorio Fabra, Seccion Astronomica. Nos. 5—6. Barcelona, 1921. 4to.	The Royal Academy of Barcelona.
Belgrade. Théorie mathématique des Phénomènes Thermiques. By M. Milankovitch. Paris, 1920. 8vo.	The Author.
Brera. Reale Osservatorio di Brera in Milano. Pubblicazioni. Nos. 55—57. Milan, 1921. 4to.	The Observatory.
Brussels. Annales de l'Observatoire Royal de Belgique. 3e Série. Tome I. fasc. I. Brussels, 1921. 4to.	,,
Cape of Good Hope. Royal Observatory. Annals. Vol. VIII. Part 5; Vol. X. Parts 5 and 6. London, 1921. Fscp. Cape Meridian Observations, 1912–17. Cape 2nd Fundamental Catalogue, 1900. London, 1920, 1921. 4to.	,,
Cartuja, Granada. La Estacion Sismologica y el Observatorio Astronomico y Meteorologico de Cartuja (Granada). Granada, 1921. 8vo.	,,
Frankfurt am Main. Mitteilungen der Universitäts-Sternwarte. Arbeiten des Planeteninstituts. Heft I. Berlin, 1919. 4to.	,,
Greenwich, Royal Observatory. Photo-heliographic Results, 1916. London, 1921. 4to. Catalogue of Double Stars, 1893–1919. London, 1921. 4to. Observations made with the Cookson Floating Zenith Telescope, 1911–1918. London, 1921. 4to.	,,
Harvard College Observatory. Annals. Vol. LXXXIII. Part 5; Vol. LXXXIV. Parts 5 and 6; Vol. XCV. Cambridge, Mass., 1921. 4to. Bulletins. Nos. 747—765. Cambridge, Mass., 1921–2. 4to. Circulars. Nos. 224—230. Cambridge, Mass., 1921–2. 4to.	,,
Heidelberg. Veröffentlichungen der Badischen Sternwarte (Königstuhl). Vol. VII. Nos. 4—10; Vol. VIII. Nos. 1—3. Karlsruhe, 1913–21. 4to.	The Director.

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Hyderabad. Nizamiah Observatory. Publications. Astrographic Catalogue. Vol. IV. Edinburgh, 1921. 4to.	The Observatory.
Johannesburg, Union Observatory. Circulars. Nos. 52—53. Johannesburg, 1921. 4to.	,,
Kodaikanal Observatory. Bulletins. Nos. 66—68. Madras, 1921. 4to.	,,
Leiden. Annalen van de Sterrewacht. Band IX. Part 2 to Band XII. Part 2. Haarlem, 1913–20. 4to.	,,
Leiden. Bulletin of the Astronomical Institutes of the Netherlands. Nos. 1—11. Leiden, 1921–2. 4to.	The Institutes.
Leiden. Observations of Variable Stars. By W. J. Luyten. Leiden, 1921. 8vo.	The Author.
Lick Observatory. Bulletins. Nos. 330—333. Berkeley, Cal., 1921. 4to. Publications. Vol. XIV. Part 1. Berkeley, Cal. 4to.	The Observatory.
London, Royal Astronomical Society. Monthly Notices. Vol. LXXXI. No. 4 —Vol. LXXXII. No. 3. London, 1920–1. 8vo.	The Society.
Lowell Observatory, Arizona. Bulletin. Nos. 76 and 83. Flagstaff, 1921. 4to.	The Observatory.
Minnesota. Carleton College. Publications of the Goodsell Observatory. Nos. 8 and 9. Northfield, Minn., 1920. 8vo.	The College.
Mount Wilson Observatory. Communications to the National Academy of Sciences. Nos. 71 and 72. Washington, 1921. 8vo.	The Observatory.
Moscow. Annales de l'observatoire astronomique de Moscou. 2e Série. Vol. VI. Moscow, 1917. 4to.	,,
Ottawa. Dominion Observatory. Publications. Vol. V. Parts 2—4. Ottawa, 1921. 4to.	,,
Perth, West Australia. Astrographic Catalogue. Vols. V.—XVI. Perth, 1919–21. 4to.	,,
Potsdam. Astrophysical Observatory. Publications. No. 77. Potsdam, 1921. 4to.	,,
Prague. Astronomische Beob. der Sternwarte der deutschen Universität. No. 1. Prague, 1921. 4to.	,,
Princeton, N.J. University Observatory. Contributions. No. 5. Princeton, N.J., 1920. 4to.	,,
Rio de Janeiro. Observatorio Nacional. Annuario, 1922. Rio de Janeiro, 1921. 8vo.	,,
Rome. Specola Astronomica Vaticana. Nos. III., VII., VIII., IX. Rome and Vienna, 1911–17. 4to.	,,
San Fernando. Instituto y Observatorio de Marina. Carte du Ciel. 44 Plates. Catalogo Astrofotografico. Tomes I. and II. pt i. San Fernando, 1921. 4to.	The Institute.
Stockholm. Astronomiska Iakttagelser och Undersökningar. Band X. Nos. 7—9. Stockholm, 1920. 4to.	The Observatory.
Tokyo. Annales de l'observatoire astronomique. Tome V. fasc. 4 and app. No. 9. Tokyo, 1921. 4to.	,,
Tortosa. Observatorio del Ebro, Roquetas, Spain. Boletín Mensual. Vol. XI. No. 10—Vol. XII. No. 6. Tortosa, 1921. 4to.	,,
Upsala. Arkiv for Matematik, Astronomi och Fysik. Band XI. No. 1; XII. No. 9; XIII. No. 3. Upsala. 8vo. Kungl. Svenska Vetenskaps-akademiens Handlingar. Band LXI. No. 15. Stockholm, 1921. 8vo.	,,
Victoria, B.C. Dominion Astrophysical Observatory. Publications. Vol. I. Nos. 13—25; Vol. II. No. 1. Ottawa, 1920–1. 4to.	,,
Washington. United States Naval Observatory. American Ephemeris. 1923. Washington, 1921. 8vo. Publications. Vol. IX. Part 1. Washington, 1920. 4to.	,,
Wellington, N.Z. Bulletins of the Hector Observatory. Nos. 34—37. Wellington, 1921. Various.	,,
Wilno. Bulletin de l'Observatoire astronomique. Section I. No. 1, 1921; Section II. Nos. 1 and 2, 1921. Wilno, 1921. 8vo.	,,
Wisconsin. Washburn Observatory of the University of Wisconsin. Publications. No. XIII. Part 1. Madison, 1919. 4to.	,,
Zi-Ka-Wei. Annales de l'Observatoire astronomique de Zo Se. Tome XII. Shanghai, 1921. 4to.	,,

METEOROLOGY.

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Argentina, Oficina Meteorologica Nacional. Boletin Mensual, Sept. 1918—Feb. 1919. Buenos Aires, 1921. 4to.	The Office.
Australia. Commonwealth Bureau of Meteorology. Maps. Rainfall, 1920. Melbourne, 1921.	The Bureau.
Batavia. Royal Magnetical and Meteorological Observatory. Observations made at the Royal Magnetical and Meteorological Observatory. Vols. XXXVI. and XXXIX. and Appendix to XXXVIII. Batavia, 1920. Fol. Verhandlingen. Nos. 7 and 8. Batavia, 1921. 8vo. Regenwaarnemingen in Nederlandsch-Indië. 1915–18. Batavia, 1920. 8vo.	The Observatory.
Brera. R. Osservatorio astronomico di Brera in Milano. Osservazioni Meteorologiche e Geofisiche, 1919. Milano, 1920. 4to.	,,
Canada. Dominion Meteorological Service. Monthly Record of Observations, Dec. 1920—July 1921. Toronto, 1921. 4to.	Department of Marine and Fisheries.
Christiania. Geophysical Publications. Vol. I. Nos. 2 and 5; Vol. II. No. 1, Part 2, Nos. 3 and 4. Christiania, 1921. 4to.	Geophysical Commission.
Christiania. Norwegisches Meteorologisches Institut. Aarsberetning. 1919–20. Kristiania, 1920. 8vo. Jahrbuch. 1920. Kristiania, 1921. Fol.	The Institute.
Christiania. Norske Meteorologische Institut. Nedbφriagttagelser i Norge. 1920. Kristiania, 1921. Fol.	,,
Greenwich, Royal Observatory. Magnetic and Meteorological Results, 1916. London, 1921. 4to.	The Observatory.
Holland. Institut météorologique royal. Caractère Magnétique de chaque jour des mois. 1920 Trim. 4, 1921 Trims. 2 and 3. de Bilt. Fol.	The Institute.
India. Meteorological Department. Memoirs. Vol. XXI.; Vol. XXII. Parts 4, 5, 6. Calcutta, 1920. 4to. Monthly Weather Review. Sept. 1916—Mar. 1918. Calcutta, 1916. 4to. Rainfall Data. 1916–19. Calcutta, 1917–20. Fscp.	The Indian Government.
London. British (Terra Nova) Antarctic Expedition, 1910–1913. Terrestrial Magnetism. London, 1921. 4to.	Scott Memorial Fund.
London, Meteorological Office. Daily Weather Reports. Section I. April, 1921—Mar. 1922. London. 4to. British Meteorological and Magnetic Year Book. Part I. 1921–2; Part II. 1921–2; Part III. 1, 1921; Part III. 2, 1920; Part V. 1910 Charts and 1914. London. 4to.	The Committee.
Mauritius, Royal Alfred Observatory. Results of the Magnetical and Meteorological Observations. Aug. 1920—Jan. 1921. Mauritius. 4to.	The Observatory
Moncalieri Osservatorio del Real Collegio Carlo Alberto. Bollettino Meteorologico e Geodinamico. Osservazioni Meteorologiche. 1919. Moncalieri, 1920. 8vo.	The Observatory.
New Zealand. Government Meteorological Observatory. Meteorological Tables from the New Zealand Gazette. Jan.—Nov. 1921. Wellington, 1921–2. Fscp.	,,
Upsala. Bulletin Mensuel de l'Observatoire Météorologique de l'Université d'Upsala. Vol. LII. 1920. Upsala, 1921. 8vo.	The Observatory.
Utrecht. Koninklijk Nederlandsch Meteorologisch Institut. Ergebnisse Aerologischer Beobachtungen. 1918–19. Utrecht, 1920. 8vo. Jaarboek A Meteorologie, B Aard-magnetisme. 1918–19. Utrecht, 1920. 4to.	The Institute.

Cambridge: Printed at the University Press